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[TITLE]	Claim 1
[TITLE]	Specification 1
[TITLE]	Drawings 1
[TITLE]	Abstract 1
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[DOCUMENT NAME] Scope Of Claims

[CLAIM 1] A method for manufacturing solid-state imaging device, wherein a transparent substrate, wherein a number of spacers surrounding around said solid-state imaging elements are formed, is adhered by an adhesive onto a wafer whereon a number of solid-state imaging elements are formed, and said transparent substrate and said wafer are divided based on said solid-state imaging device for each,

characterized in that after adhering a transfer plate coated with said adhesive is put on the top of said spacers of said transparent substrate and pressing said transfer plate and said transparent substrate, said transfer plate is stripped off from said transparent substrate so as to form by transforming a layer of said adhesive on said spacer.

[CLAIM 2] A method for manufacturing solid-state imaging device claimed in claim 1, characterized in that said transfer plate is a rigid body.

[CLAIM 3] A method for manufacturing solid-state imaging device claimed in claim 2, characterized in that said transfer plate applies a glass plate as a rigid body.

[CLAIM 4] A method for manufacturing solid-state imaging device claimed in claim 1, characterized in that said transfer plate is an elastic body.

[CLAIM 5] A method for manufacturing solid-state imaging device claimed in claim 4, characterized in that said transfer plate applies a flexible plastic film as an elastic body.

[CLAIM 6] A method for manufacturing solid-state imaging device claimed in one of claim 1 or 5, characterized in that a ridge pattern or a recess pattern, which is the same shape as said spacers formed on said transparent substrate, is formed on said transfer plate.

[CLAIM 7] A method for manufacturing solid-state imaging device claimed in one of claim 1 or 6, characterized in that a release agent is coated on the surface of said transfer plate.

[CLAIM 8] A method for manufacturing solid-state imaging device claimed in claim 7, characterized in that said release agent is silicon.

[CLAIM 9] A method for manufacturing solid-state imaging device claimed in one of claim 1 or 8, characterized in executing a surface modification process to the end surface of said spacer to be coated with said adhesive.

[CLAIM 10] A method for manufacturing solid-state imaging device claimed in one of claim 1 or 9, characterized in that a viscosity of said adhesive as coated on said transfer plate is more than 0.1Pa·s.

[CLAIM 11] A method for manufacturing solid-state imaging device claimed in one of claim 1 or 10, characterized in that said transfer plate is coated with said adhesive by applying bar coat, blade coat, or spin coat.

[CLAIM 12] A method for manufacturing solid-state imaging device claimed in one of claim 1 or 11, characterized in that said transfer plate and said transparent substrate is pressed by air pressure or roller pressure.

[CLAIM 13] A method for manufacturing solid-state imaging device claimed in one of claim 1 or 12, characterized in that said viscosity of said adhesive on said transfer plate as transferred on said spacer is 100-10000Pa・s.

[CLAIM 14] A method for manufacturing solid-state imaging device claimed in one of claim 1 or 13, characterized in that said adhesive has a thickness of less than 0.5μm-5μm as hardened.

[CLAIM 15] A method for manufacturing solid-state imaging device claimed in one of claim 1 or 14, characterized in that entire adhering surface of said spacer is adhered to a wafer.

[CLAIM 16] A solid-state imaging device, characterized in manufactured by manufacturing methods claimed in one of claim 1 to 15.

[CLAIM 17] A solid-state imaging device claimed in claim 16, characterized in that chasms of 50-100μm are formed between the whole edge of said solid-state imaging element and the inner surface of said spacer.

[CLAIM 18] A solid-state imaging device claimed in one of claim 16 or 17, characterized in that the width of a frame of said spacer is 100-500μm.

[CLAIM 19] A solid-state imaging device claimed in one of claim 16 or 18, characterized in providing chamfer parts for containing protruding adhesive at an edge of an end surface of said spacer to be adhered to said wafer.

[CLAIM 20] A solid-state imaging device wherein a spacer of a frame form surrounding solid-state imaging elements is

adhered onto a chip substrate whereon said solid-state imaging elements are formed, and a transparent plate on said spacer seals said spacer,

characterized in that chasms of 50-100 μm are formed between the whole edge of said solid-state imaging element and the inner surface of said spacer.

[CLAIM 21] A solid-state imaging device wherein a spacer of a frame form surrounding solid-state imaging elements is adhered onto a chip substrate whereon said solid-state imaging elements are formed, and a transparent plate on said spacer seals said spacer,

characterized in that the width of a frame of said spacer is 100-500 μm.

[TITLE OF DOCUMENT] Specification

[TITLE OF THE INVENTION] Solid-state imaging device and method or manufacturing the same.

[FIELD OF INVENTION]

[0001]

The present invention relates to a solid-state imaging device applying a wafer level chip size package structure and to methods for manufacturing the solid-state imaging device.

[PRIOR ARTS]

[0002]

Digital cameras, wherein a solid-state imaging device and a semiconductor memory are used instead of silver salt film, are commonly used. Small electronic equipment such as a mobile phone and an electronic databook, wherein the solid-state imaging device and the semiconductor memory are mounted so as to enable photographing, are also widely used. In a conventional solid-state imaging device, a solid-state imaging element chip, wherein solid-state imaging elements such as CCD or the like are provided on a silicon substrate, is bonded to a package formed of ceramic or the like, and after electrically connecting the solid-state imaging element chip and a terminal of the package by using a bonding wire, a glass lid formed of transparent glass is attached to the package so as to seal the solid-state imaging element chip.

[0003]

In order to downsize the digital cameras and small electronic equipment, it is desired to downsize the solid-state

imaging device. As one of implementation methods for downsizing the solid-state imaging device, there is a wafer level chip size package method (hereinafter CSP) completing implementation of the solid-state imaging device at a wafer level without using the package (see Reference 1 as an example). In this solid-state imaging device using the wafer level CSP, spacers are arranged with surrounding around the solid-state imaging device onto the upper surface of the solid-state imaging element chip, a cover glass is attached on the spacers so as to seal the solid-state imaging element, and connecting terminals are formed on the upper surface, side surfaces, and a lower surface of the solid-state imaging element chip.

[0004]

The solid-state imaging device applying the wafer level CSP is manufactured as follows. First, forming a number of spacers on a transparent glass substrate, which is a base material for a cover glass. Next, coating ends of each spacer with adhesive, and after adhering together the glass substrate and a wafer wherein a number of solid-state imaging elements are formed. Then, forming a number of solid-state imaging elements by dicing and separating the glass substrate and the wafer.

[0005]

A certain chasm is required between the solid-state imaging element and the spacer. This is to prevent the light reflected at the inner surface of the spacer from entering the solid-state imaging element and generating flare and the like. Also, that is to prevent distortion caused stress, generated by pressing

the wafer and the spacer to each other as adhering, from influencing the solid-state imaging element. Furthermore, that is to prevent distortion caused by the difference of coefficients of thermal expansion of the solid-state imaging element chip and the spacer from influencing the solid-state imaging element, since the solid-state imaging element has large calorific value when driven in a high clock or exposed for a long hours.

[0006]

[Reference 1] Japan Patent Laid-open Publication Number 2002-231921

[DISCLOSURE OF INVENTION]

[PROBLEMS TO BE SOLVED BY THE INVENTION]

[0007]

When adhering the spacer and the wafer, they must be sealed appropriately such that the adhesive coated on the spacer would not protrude or flow onto the solid-state imaging element, and so as not to provide a chasm between the spacer and the wafer. This is because image noise is caused if the adhesive flows onto the solid-state imaging element, and because cooling water as dicing enters the spacer if there is the chasm between the spacer and the wafer. Since such solid-state imaging element being caused those defects cannot be applied to a product, yield is deteriorated.

[0008]

In order to appropriately adhere the spacer and the wafer, the thickness of the adhesive coated on the spacer needs to be

thin and even. However, by the method of adhering by means of potting by dropping a small amount of the adhesive having high viscosity as cited in the Reference 1, it is impossible to coat the adhesive to the frame of the spacer having a width of less than 200 μm. Even if the frame of the spacer has the width of more than 200 μm, it takes too much time to execute potting to each side of a number of spacers on the glass substrate.

[0009]

Though it is cited in the Reference 1 to coat the adhesive on the spacer by printing, it may be hardly realized, as it is hard to align printing positions to each spacers and to control the thickness of the coating. Furthermore, silicon used as the material of the spacer tends to repel the adhesive, and that makes very difficult to coat the adhesive with even thickness onto the spacers having minute dimensions.

[0010]

In order to adhere the spacer and the wafer appropriately, the width of the frame of the spacer is an important element. If the width of the frame is too wide, an adhering defect such as remained air in the adhesive is likely to occur. Additionally, it makes difficult to downsize the solid-state imaging device, and results in cost-up because of decreasing of the number of the spacer adhering to the wafer. To the contrary, if the width of the spacer is too narrow, defects of the intensity is likely to be generated.

[0011]

In order to prevent the adhesive from flowing onto light

receiving surface, it is conceivable to lengthen the distance between the solid-state imaging element and the spacer. However, it results in cost-up as well because of decreasing of the number of the spacer adhering to the wafer.

[0012]

The present invention is to solve the above problems and aims to adhere the solid-state imaging element chip and the spacer appropriately.

[MEANS FOR SOLVING THE PROBLEMS]

[0013]

In order to solve the above problems, a method for manufacturing a solid-state imaging device of the present invention is after adhering a transfer plate coated with an adhesive onto a spacer, which is a transparent substrate, and pressing the transfer plate and the transparent substrate, stripping off the transfer plate from the transparent substrate to transfer-form a adhesive layer.

[0014]

As the transfer plate, a rigid body such as glass and a elastic body such as flexible plastic film and the like may be used, and they may be selected according to the number of the spacer and the type of the adhesive. Additionally, by forming a ridge pattern or a recess pattern, the same form as the spacer, on the transfer plate, the adhesive coated onto the pattern may be transferred to the spacer. Furthermore, it is also possible to coat a release agent such as silicon to the transfer plate and coat the adhesive on the release agent.

[0015]

Additionally, it is possible to executing a surface modification process to the surface of the spacer to be coated with the adhesive. A viscosity of the adhesive is preferably more than 0.1Pa・s, in order to control the coating thickness easily. The transfer plate may be coated with the adhesive evenly by any of applying bar coat, blade coat, or spin coat. Moreover, the transfer plate and the transparent substrate may be adhered to each other evenly by being pressed with air pressure or roller pressure.

[0016]

The viscosity of the adhesive on the transfer plate as transferring to the spacer is 100-10000Pa・s. Furthermore, the entire adhering surface of the spacer coated with the adhesive is adhered onto the chip substrate.

[0017]

Moreover, the following constitutions may also be added to the solid-state imaging device manufactured by the manufacturing method stated above. One of the constitutions is: chasms of 50-100μm are formed between the whole edge of the solid-state imaging element and the inner surface of the spacer. Also, the width of a frame of said spacer is 100-500μm. Furthermore, chamfer parts for containing protruding adhesive are provided at an edge of an end surface of the spacer to be adhered to the wafer.

[EFFECT OF THE INVENTION]

[0018]

According to the method for manufacturing the solid-state imaging device of the present invention, the adhesive may be coated thinly and evenly onto the spacer. Thus, the adhere the spacer and a wafer may be adhered appropriately without protruding adhesive and sealed without a chasm between them.

[0019]

If a rigid body is used as the transfer plate, the thickness of the adhesive to be coated on the spacer may be controlled precisely, as the transfer plate has high planarity. Furthermore, if a rigid body is used as the transfer plate, since the transfer plate may be adjusted along the spacer, the coating thickness of the adhesive may be controlled precisely regardless an error of measurement of the spacer or the transparent substrate.

[0020]

If a ridge pattern having the same shape of the spacer is formed on the surface of the transfer plate, it may contact the transfer plate and the spacer more certainly. To the contrary, if a recess pattern having the same shape of the spacer is formed on the surface of the transfer plate, the amount of the adhesive to be transferred may be adjusted according to the depth of the recess pattern.

[0021]

If the surface of the transfer plate is coated with a release agent, the adhesive is easily stripped off from the transfer plate and it enables to transfer the adhesive coated on the transfer plate to the spacer directly. Thus, controlling the

coating thickness to the transfer plate may control the coating thickness of the adhesive to the spacer. Furthermore, by executing a surface modification process to the surface of the spacer to be coated with the adhesive, a coating property of the adhesive is improved and may be coated more evenly.

[0022]

As the viscosity of the adhesive is determined to be lower as more than 0.1Pa·s, the coating thickness may be controlled easily. Additionally, as generally used bar coat, blade coat, spin coat, and the like may be applied for coating the adhesive to the transfer plate, the adhesive may be coated with low cost and with further precise thickness. Furthermore, the transfer plate and the transparent substrate are pressed by air pressure or roller pressure, the entire area of the transfer plate and the transparent substrate may be pressed evenly, and the adhesive is certainly to be transferred to the spacer.

[0023]

Since the viscosity of the adhesive is determined to be higher as 100-10000Pa·s as transferring the adhesive on the transfer plate to the spacer, the adhesive does not flow and, at the same time, improves handling property of the transfer plate and the transparent substrate. Moreover, since the thickness of the adhesive after hardened is determine to be less than 0.5-5μm, the coating thickness of the adhesive may be thicken and the amount of the adhesive protruding from under the spacer may be reduced. Additionally, a chasm between the spacer and the wafer may not be appeared caused by luck of the

adhesive. Furthermore, since the entire adhering surface of the spacer is adhered to the wafer, the adhesive intensity may be controlled by selecting appropriately the width of the frame of the spacer.

[0024]

In the solid-state imaging device manufactured by the above manufacturing method, since a chasm of 50-100 μm is formed between the whole edge of the solid-state imaging element and the inner surface of the spacer, the adhesive protruding from under the spacer does not flow onto the solid-state imaging element. Additionally, the chasm between the solid-state imaging element and the inner surface of the spacer may prevent the light reflected on the inner surface of the spacer from entering the solid-state imaging element. Furthermore, it may prevent distortions as adhering the wafer and the spacer and the influence by the distortion caused by the calorification of the solid-state imaging element.

[0025]

As the width of the frame of the spacer is determine as 100-500 μm, the adhesive is certainly coated and enough intensity may be gained. Furthermore, it may achieve cost-down as the number of the spacer adhering to the wafer is increased.

[0026]

Furthermore, the adhesive protruding from under the spacer may be contained by chamfer parts formed at the edge of the end surface of the spacer. Thereby, it may prevent the adhesive from flowing onto the solid-state imaging element.

[BEST EMBODIEMENTS OF THE INVENTION]

[0027]

Fig.1 and Fig.2 respectively show a perspective view of an apparent form and a main part partial cross view of a solid-state imaging device of the wafer level CPS structure, wherein the present invention is executed. The solid-state imaging device 2 is composed of a solid-state imaging element 3, a rectangular-shaped solid-state imaging element chip 5, on which a plural of connecting terminal 4 are provided to connect electrically to the solid-state imaging element 3, a frame-shaped spacer 6 attached onto the chip 5 to surround the solid-state imaging element 3, and a cover glass 7 attached on the spacer 6 to seal the sold-state imaging element 3. As the cover glass 7, an α beam shielding glass is used so as to prevent photo diode of the CCD from being destructed.

[0028]

The solid-state imaging element 3 is composed of CCD, for example, and a color filter, a micro lens, and the like are laid on the CCD. The connecting terminal 4 is formed by printing on the solid-state imaging element chip 5 with using, for example, a conductive material. Similarly, the connecting terminal 4 and the solid-state imaging element 3 are wired together by printing. The solid-state imaging element chip 5 is formed by dicing each solid-state imaging element after a number of solid-state imaging elements 3 and connecting terminals 4 are formed on the wafer.

[0029]

The spacer 6 is formed of an inorganic material, such as silicon, for example. The height H of the spacer 6 is 10-500 μm for example, and preferably 80-120μm. The adhesive 12 to adhere the solid-state imaging element chip 5 and the spacer 6 has the thickness T2 less than 0.5-5μm.

[0030]

A chasm C is formed between the whole edge of the solid-state imaging element 3 and the inner surface of the spacer 6. The chasm C is provided so as to prevent the light reflected on the inner surface of the spacer 6 from entering the solid-state imaging element 3, and to prevent the distortion generated the adhering part of the spacer 6 and the solid-state imaging element chip 5 from influencing the solid-state imaging element 3. The distortion of the adhering part of the spacer 6 and the solid-state imaging element chip 5 is generated as the wafer, a substrate of the solid-state imaging element chip 5, and a glass substrate, on which a spacer 6 is formed, are pressed to each other to adhere. Alternatively, if the solid-state imaging device 2 is driven at high clock or exposed for a long hours, the temperature of the solid- state imaging element 3 is raised, and the distortion is generated because of the difference of their coefficients of thermal expansion.

[0031]

Fig.3 is a flow chart showing a manufacturing process of the above solid-state imaging device. In the first step, as shown in Fig.4, a number of the spacers 6 are formed on the glass substrate 10, which is a substrate of the cover glass 7. Those

spacers 6 are formed by the following method: for example, first, laying the inorganic material such as silicon and the like by coating by spin coat and the like or by a CVD device so as to form an inorganic material membrane. Next, forming a number of spacers 6 out of the inorganic material membrane by means of a photolithography technique, development, etching, and the like. Note that it is possible to adhere the glass substrate 10 and the silicon wafer together so as to form the inorganic material membrane on the glass substrate 10. Furthermore, the spacer may also be formed directly by printing the inorganic material onto the glass substrate 10.

[0032]

As shown in Fig.5, an adhesive 12 is coated to the end faces of the spacers 6 on the glass substrate 10 thinly and evenly in the second step. As the adhesive 12 to use adhere the spacer 6 and the wafer, for example, epoxy resins, silicon resins, and the like are used to prevent from deformation as hardening and from entering of water to gain high reliability. Additionally, the viscosity V1 of the adhesive as coating is determined as 0.1-10Pa・s so as to improve the controlling of the coating thickness of the adhesive 12. Note that UV hardened adhesive, visible light hardened adhesive, and heat hardened adhesive may be used if they provide the same effect.

[0033]

The coating of the adhesive to the spacer 6 is executed by from the second-1 to the second-4 steps shown in from Fig.6 to Fig.8. In the second-1 step, a transfer film 16 is put on a work

table 15, which is made of glass to have high planarity, as shown in Fig.7(A). The transfer film 16, used as a transfer plate, is held on the work table 15 by being sucked by means of air suction or electrostatic suction not to shift or to generate wrinkles.

[0034]

The transfer film 16 is a thin film formed to be flat by means of polyethylene terephthalate (PET) and has an exterior size larger than that of the glass substrate 10. Onto the transfer film 16 put on the work table 15, the adhesive 12 is coated by means of a coat bar 17 of a bar coater or a spin coater with coating thickness T1 of 6-10 μm, or 8 μm more preferably. Note that a blade coater and a spin coater may be used for coating the adhesive 12 to the transfer film 16.

[0035]

It is generally known that an optical room-temperature hardened adhesive has a bad coating property to the inorganic material such as silicon when the viscosity is low, and that the coating property is improved by enhancing the viscosity. Using adhesive having high viscosity, however, makes it difficult to control the coating thickness of the adhesive 12 to coat the transfer film 16. In the present embodiment, accordingly, a time-based process is executed in the second-2 step by coating the adhesive 12 to the transfer film 16 and leaving it for a predetermined time so as to enhance the viscosity of the adhesive 12. In this time-based process, the leaving time and the environmental temperature is adjusted such

that the adhesive coated with the viscosity 1 is enhanced to a viscosity v2 for transferring: 100-10000Pa・s for example, and preferably 2000-3000Pa・s.

[0036]

Thereby, since the viscosity of the adhesive 12 is lowered when coated to the transfer film 16 and enhance when coated to the spacer 6, it is possible to have the viscosity having both of high-leveled controlling property to the transfer film 16 and high-leveled coating property to the spacer 6 as transferring. Since the adhesive 12 hardly flows by enhancing the viscosity of the adhesive 12, a handling property of the transfer film 16 and the glass substrate 10 after transferring the adhesive 12 may be improved. Furthermore, the amount of the adhesive 12, protruding from under the spacer 6 as adhering the spacer 6 and the wafer 26, may be reduced.

[0037]

Note that, if using the hydrophilic adhesive, the spacer 6 may be executed surface modification by emitting plasma or ultraviolet rays to the spacer 6. By this surface modification, the coating property of the adhesive to the silicon spacer may be improved.

[0038]

In the second-3 step, the glass substrate 10 and the transfer film 16 are adhered to each other by alignment equipment or by hand. For example, as shown in Fig.7(B), the alignment equipment is composed of a glass holder table 20 for holding by sucking the glass substrate 10 by means of the air suction from a suction

holes 20a, and a film holder table 21, which is disposed below the glass holder table 20, executes air suction from the suction holes 21a to hold the transfer film 16 via a sponge 21b by sucking. The film holder table 21 is movable into up and down direction in the same manner as a well-known Z-axis moving table.

[0039]

The film holder table 21 moves upward while the transfer film 16 coated with the adhesive 12 is put on the sponge 21b, so as to press evenly the transfer film 16 to a number of spacers 6 on the glass substrate 10. The sponge 21b to be used has hardness capable of pressing the transfer film 16 firmly to the spacers 6 without breaking the spacers 6. Thus, the adhesive 12 on the transfer film 16 and the spacers 6 are certain to contact to each other, and the glass substrate 10 and the transfer film 16 are adhered to each other. Note that it is possible to blow air and press the glass substrate 10 or the transfer film 16, and that the glass substrate 10 and the transfer film 16 may be adhered to each other by shifting a pressure roller on the glass substrate 10.

[0040]

In the second-4 step, the transfer film 16 is stripped off from the glass substrate 10, and the adhesive 12 is transferred onto the spacers 6. As shown in Fig.8, the film peeling equipment used in this step is composed of a work table to hold the glass substrate 10 put on the work table by sucking by means of air suction and the like, a winding roller 22 to engage one end of the transfer film 16, and a peeling guide 24 to keep the angle

θ between the transfer film 16 and the glass substrate 10 constant when they are being peeled, with abutting the upper surface of the transfer film 16. The work table 22 is slidable horizontally in the figure by, for example, a table shifting mechanism used for a XY table.

[0041]

In the film peeling equipment, the winding roller 23 is started to wind the transfer film 16 simultaneously with the work table 2 slides into the left side in the figure, so as to peel the transfer film 16 sequentially from one end of the glass substrate 10. In this time, since the rear surface of the transfer film 16 is limited by the peeling guide 24, the angle θ between the transfer film 16 and the glass substrate 10, and the adhesive 12 is transferred in a certain thickness onto each spacer 6 on the glass substrate 10. Note that, if the size of the transfer film 16 is not large to be able to engage with the winding roller 23, an extension film may be attached to one end of the transfer film 16.

[0042]

In the third step, as shown in Fig.9(A), the glass substrate 10 is adhered onto a wafer 26, on which a number of solid-state imaging elements 3 and connecting terminals 4 are formed. Note that the glass substrate 10 and the wafer 26 have the same size and the same shape, as shown in Fig.10. An alignment bonding equipment is used to adhere the glass substrate 10 and the wafer 26. The alignment bonding equipment comprises a bonding table 28 to hold and position the wafer 26 by sucking air from air

suction holes 28a and a positioning table 29 to hold the glass substrate 10 by sucking air from suction holes 29a to adjust the position of the XY direction and rotating direction of the glass substrate 10 according to the wafer 26.

[0043]

The positioning table 29 adjusts the positions of the wafer 26 and the glass substrate 10 by using orientation flat lines 26a and 10a of the wafer 26 and the glass substrate 10, and alignment marks provided appropriately. Then, the positioning table 29 moves downward to overlap the glass substrate 10 on the wafer 26 and presses evenly the entire glass substrate 10 with relatively weak pressure. Thereby, the glass substrate 10 and the wafer 26 are temporarily adhered. Note that the reason of that the sponge used in the alignment equipment in Fig.7(B) is not used in the alignment bonding equipment for adhering the glass substrate 10 and the wafer 26 is that, in adhering the glass substrate 10 and the wafer 26, highly precise positioning adjustment is required between the solid-state imaging elements 3 and the spacers 6.

[0044]

The glass substrate 10 and the wafer 26 temporarily attached each other by the alignment bonding equipment is adhered firmly by a pressure bonding equipment shown in Fig.9(B) not to peeled off from each other. The pressure bonding equipment comprises a bonding table 30 for positioning and holding the glass substrate 10 and the wafer 26 by means of air suction from air suction holes 30a, and a pressure table 33 positioned over the

bonding table 30 for pressing evenly the glass substrate 10 via a sponge 33a. The pressure by the pressure bonding equipment to the glass substrate 10 and the wafer 26 is continued for a predetermined time until the adhesive 12 is hardened.

[0045]

The width W of the frame of the spacer 6 influences not only to the intensity of the spacer 6 but to adhering intensity and adhering condition of the spacer 6 and the wafer 26 as well. When the width W is large, adhering errors such as remaining air in the adhesive 12 are likely to occur, though the intensity is increased. Additionally, since the size of the spacer 6 is increased, it obstructs the downsizing of the solid-state imaging device 2, and causes cost-up because of decreasing of the number of the spacer 6 adhering to the wafer 26. To the contrary, if the width W is too narrow, the adhering intensity of the spacer 6 and the wafer 26 is dropped.

[0046]

In the present invention, the width W of the spacer 6 is determined as 100-500μm and selected appropriately based on the size of the solid-state imaging element 3. For example, if the solid-state imaging element 3 has a size of 1/7 inch, the width W is set 200μm. Thus, enough intensity may be gained, and the spacer 6, having little adhering errors and not reducing the number of the spacer 6 adhering to the wafer 26, may be formed.

[0047]

As shown enlarged in Fig.2, the adhesive 12 may protrude

from under the spacer 6, when the glass substrate 10 is adhered onto the wafer 26 by the pressing adhering device. Though it is no problem if the amount of the protruding adhesive 12 is very small, it causes noise if the protruding adhesive 12 flows onto the solid-state imaging element 3. However, since it is determined that the adhesive 12 has a high viscosity as adhered, the amount of protruding adhesive 12 is small. Additionally, since the adhesive 12 protruding from under the spacer 6 is contained in the chamfer C provided between the edge of the end surface of the solid-state imaging element 3 and the inner surface of the spacer 6, the adhesive 12 does not flow onto the solid-state imaging element 3.

[0048]

Note that the adhesive 12 protruding from under the spacer 6 flows onto the solid-state imaging element 3, if the chamfer C is too narrow. In addition, reflection of the light on the inner surface of the spacer 6 and a distortion in the adhering part of the spacer 6 influences on the solid-state imaging element 3. To the contrary, it obstructs the downsizing of the solid-state imaging device 2 and, at the same time, causes cost-up because of decreasing of the number of the solid-state imaging element chip 5 adhering to the wafer 26, if the chamfer C is too wide.

[0049]

The applicant experimented to analyze the correlation between the viscosity of the adhesive 12 and the protruding amount of the adhesive 12. This experiment was to measure the

amount of the adhesive 12 protruding from the inner surface of the spacer, by adhering spacers coated with adhesive having various viscosities and the wafer. According to the result of this experiment, it revealed that the protruding amount is reduced in proportion to the viscosity of the adhesive 12. Especially, the amount of the protruding adhesive was held under 65 μm, when the viscosity V2 of the adhesive 12 on the transfer film 16 to be transferred to the spacer 6 is 100-10000Pa・s, preferably 2000-3000Pa・s, as described above.

[0050]

According to the above results, it may prevent the adhesive 12 from flowing onto the solid-state imaging element 3, with minimizing the glowing size of the solid-state imaging device 12 as much as possible, by determining the chamfer C as 50-100 μm, preferably 65-80 μm. In addition, by determining the chamfer C as the above size, the influence by the reflection of the light on the inner surface of the spacer 6 and distortion in the adhering part of the spacer 6 may be overcome.

[0051]

As shown enlarged in Fig.2, the thickness T2 of the adhesive 12 hardened by the pressing adhering device is reduced less than the thickness T1 of the adhesive 12 coated on the transfer film 16. This is because when the adhesive is transferred from the transfer film to the spacer 6, some adhesive 12 is remained and the thickness is decreased, and the thickness is more reduced by the adhesive 12 protrudes as adhering the spacer 6 and the wafer 26.

[0052]

According to the experiment by the applicant, a result is drawn that, if the thickness T2 of the adhesive 12 after hardened is 0.5-5μm, the chamfer is not generated between the spacer 6 and the solid0state imaging element chip5 and that an appropriate adhering intensity may be gained. Therefore, the coating thickness T1 of the adhesive 12 to coat the transfer film 16 should have a thickness enough to maintain the thickness T2 of 0.5-5μm after hardened, with considering the remained amount as transferring and the protruding amount.

[0053]

In the fourth step, dicing of the glass substrate 10 is executed to form a number of cover glasses 7 out of the glass substrate 10, as shown in Fig.11. The dicing of the glass substrate 10 is executed by a diamond cutter 31, and cooling water is poured from an injection nozzle 32 to prevent the glass substrate 10 from heated too much. Since between the spacer 6 and the wafer 26 are certainly leased by the adhesive 12, the cooling water cannot enter the spacer 6 as dicing of the glass substrate 10.

[0054]

In the fifth step, a dicing tape 34 is attached to the lower surface of the wafer 26, as shown in Fig.12. Then, the wafer 26 is diced by the diamond cutter 35 to form a number of the solid-state imaging device 2. Though the cooling water is poured from the injection nozzle 36 as dicing the wafer 26, the cooling water cannot enter the spacer 6 as well.

[0055]

Note that, in the above embodiment, though the flexible plastic film is used as the transfer plate, a rigid body having high planarity such as glass may also be used as the transfer plate, as shown in Fig.13(A) and (B). When using the rigid body as the transfer plate, it is needed to strip off slowly the transfer plate 380from the glass substrate 10 so as to certainly transfer the adhesive to the spacer 6.

[0056]

In order to improve the peeling property of the adhesive 39 from the transfer film 16 and the transfer plate 38, a release agent 37 may be coated on the surface of the transfer film 16 and the transfer plate 38. In this case, it is recommended to use the adhesive 39, which may be coated on the release agent 37 and having better coating property to the spacer 6 than to the release agent 37. Also, a silicon-coated film, coated with the release agent preliminary such as silicon and the like, may be used as well.

[0057]

As shown in Fig.13(A), coating the adhesive 39 on the transfer plate 38, coated with the release agent 37 such as silicon. Next, the transfer plate 38 is adhered to the spacer 6 on the glass substrate 10, and separating the transfer film 38 and the glass substrate 10, as shown in Fig.13 (B). Then, since a part of the adhesive 39 adhering to the spacer 6 is stripped off from the release agent smoothly, all of the adhesive 39 on the release agent 37 may be transferred to the

spacer 6.

[0058]

Thus, since the coating thickness T3 of the adhesive 39 coated on the transfer film 38 and the thickness T4 of the adhesive 39 to be transferred to the spacer 6 become even, the amount of the adhesive 39 to be transferred to the spacer may be easily controlled by controlling the coating thickness of the adhesive 39 on the transfer film 38. Note that it is preferable to use the adhesive 39 having high viscosity.

[0059]

Furthermore, regardless of elastic bodies or rigid bodies, a ridge pattern or a recess pattern may be formed on the transfer plate. By forming the ridge pattern, the adhering condition between the transfer plate and the spacer may be more certain. By forming the recess pattern, the amount of the adhesive may be adjusted by the depth of the recess pattern.

[0060]

Additionally, like the solid-state imaging device 40 shown in Fig.14, an adhesive 44 protruding from under a spacer 41 may be contained in a chamfer 43 by providing the chamfer 43 at an edge of an end surface of the spacer 41 to be adhered to a solid-state imaging element chip 42. Thus, since the amount of the adhesive 44 protruding from under the spacer 41 is reduced, the size of the chamfer C between a solid-state imaging element 45 and the inner surface of the spacer 41 may be reduced as well.

[0061]

Note that the chamfer 43 of the above spacer 41 may be formed

by the steps shown in the flow chart in the Fig.15. First, coating an adhesive onto a glass substrate 50, a substrate of a cover glass 47, as shown in Fig.16(A), and adhering it to a wafer 52 for a spacer, which is a substrate of the spacer 41. Next, as shown in Fig.16(B), resist masks 53 having the shape of the spacer 41 is formed on a wafer 52 for the spacer.

[0062]

As shown in Fig.16(C), the wafer 52 for the spacer is treated isotopic dry etching. Thereby, the wafer 52 except the part concealed by the resist masks 53 is executed etching at a constant velocity, and the chamfers 43 are formed under the resist masks 53. Next, when executing anisotropic dry etching into a different direction to the wafer 52 for the spacer, the wafer 52 for the wafer is executed etching in a vertical direction to the resist mask 53, as shown in Fig.16(D). Then, by removing the resist masks 53 and the adhesive 51 by using ashing, a number of the spacer 41 is formed on the glass substrate 50, as shown in Fig.16(E).

[0063]

Note that the cross-sectional view of the end surface of the spacer to be adhered to the wafer may be various: other than a plane shape as shown in Fig.2 and a chamfer shape as shown in Fig.14, a ridge shape, a recess shape, a declining shape, a circular arc shape, stairs shape, a half-circular arc shape, and the like. In those shapes, the protruding adhesive may be contained to reduce the amount of the protruding adhesive.

[INDUSTRIAL AVAILABLENESS]

[0064]

Though the solid-state imaging device using CCD is explained as an example in the above embodiment, the present invention may also be applied to the solid-state imaging device of CMOS type. In addition, the present invention may be applied when adhering substrates of chips having CSP constitution in other than the solid-state imaging device.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[0065]

[Figure 1] An external perspective view illustrating a composition of a solid-state imaging device manufactured by using the present invention.

[Figure 2] A cross-sectional view of a main part illustrating a composition of the solid-state imaging device.

[Figure 3] A flow chart showing a manufacturing procedure of the solid-state imaging device.

[Figure 4] A cross-sectional view of a main part illustrating a glass substrate to which a number of spacers are formed in the first step.

[Figure 5] A cross-sectional view of a main part illustrating a adhesive is coated on the spacers of the glass substrate in the second step.

[Figure 6] A flow chart showing operating procedure in the second step.

[Figure 7] An explanatory view illustrating a transfer method of the adhesive to the spacer in the second-1 step.

[Figure 8] An explanatory view illustrating a method for

stripping off the transfer film from the spacer in the second-1 step.

[Figure 9] A cross-sectional view of a main part illustrating a condition wherein the glass substrate and the wafer are adhered together in the third step.

[Figure 10] A perspective view illustrating external shapes of the glass substrate and the wafer.

[Figure 11] A cross-sectional view of a main part illustrating dicing of the glass substrate in the fourth step.

[Figure 12] A cross-sectional view of a main part illustrating dicing of the wafer in the fifth step.

[Figure 13] An explanatory view illustrating a condition of transferring the adhesive by the second embodiment of the present invention.

[Figure 14] A cross-sectional view of a main part of the solid-state imaging device wherein the spacer is provided with a chamfer part.

[Figure 15] A flow chart showing a forming procedure of the chamfer part.

[Figure 16] A explanatory view showing a forming procedure of the chamfer part.

[Figure 17] An explanatory view illustrating variations of the shapes of the chamfer part.

[DESCRIPTION OF THE REFERENCE NUMBERS]

2 solid-state imaging device

3 solid-state imaging element

4 connecting terminal

5 solid-state imaging element chip

6 spacer

7 cover glass

10 glass substrate

12 adhesive

16 transfer film

23 winding roller

24 peeling guide

26 wafer

37 release agent

38 transfer plate

43 chamfer part

[TITLE OF DOCUMENT] Abstract

[ABSTRACT]

[OBJECT] Coating adhesive on a spacer evenly with appropriate thickness.

[RESOLUTION] A spacer 6 of a substrate 10 and a transfer film 16 coated with an adhesive 12 are adhered to each other. The glass substrate 10 is put on a work table 22, a peeling guide 24 is placed on top of the transfer film 16, and one end of the transfer film 16 is engaged with a winding roller 23. Then, the work table 22 is slide into the left side in the figure, and, simultaneously, the transfer film 16 is wound by the winding roller 23. In this time, since the rear surface of the transfer film 16 is limited by the peeling guide 24, the angle θ between the glass substrate 10 and the transfer film 16 is kept constant, and a certain thickness of the adhesive 12 is transferred to each spacer 6 of the glass substrate 10.

[ELECTED FIGURE] Figure 8